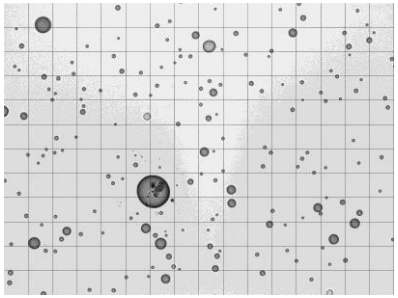
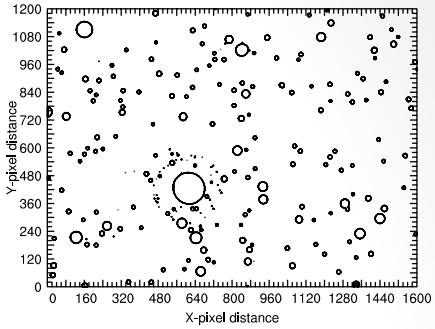
The Automatic Giant Nuclei Impactor, AutoGNI

Why measure the sizes of giant aerosols (d>1 µm):
Sea salt, mineral dust, bio aerosols

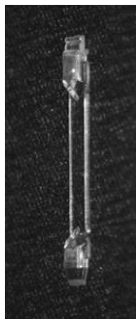
Impact on warm rain formation (sea salt)
Impact on ice precipitation (mineral dust and bio)
Impact on radiative balance (sea salt and dust)

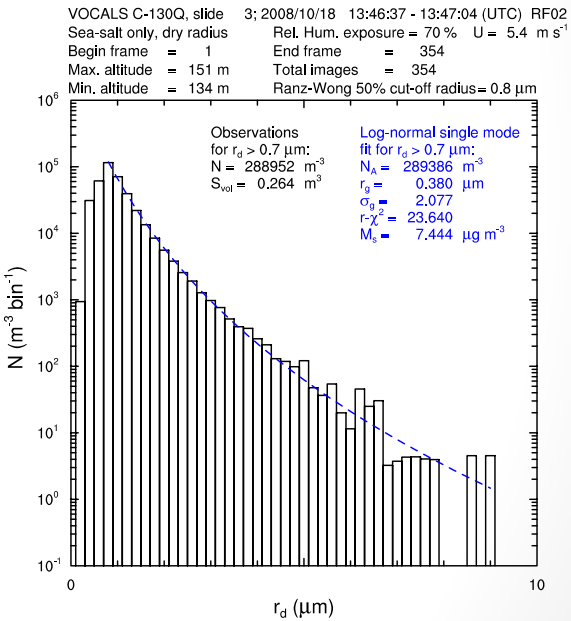


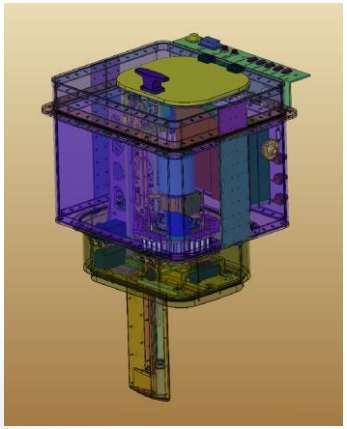


Existing:
Manual C-130 system cannot fly on GV
Excellent laboratory analysis for sea-salt, etc.

Goal:
Develop automatic exposure system (robotics)
Control from GV cabin and via internet







Enclosure

Internal

Concept:
Scientist in Colorado controlling slide exposure near Antarctica, while coding climate model

Aerosol sampling:

Sea-salt: Low 500 ft (most sampling)
Profiles (surface to max. altitude)

Smaller: Everywhere

Clouds and precipitation:

Expect 500-1500 m boundary-layer clouds
Expect
(i) cumulus
(ii) cumulus rising into upper-level stratocumulus
(iii) well-mixed stratocumulus
(iv) frontal clouds

Expect super-cooled clouds (warm clouds at T < 0C)
Expect some ice precipitation and drizzle

Fly profiles: Preferably through cloud for cloud sampling

Preferably in clear air for aerosol sampling

Key problems:

SO boundary-layer clouds are highly sensitive to changes in aerosol concentration (Trenberth and Fusillo, 2010)

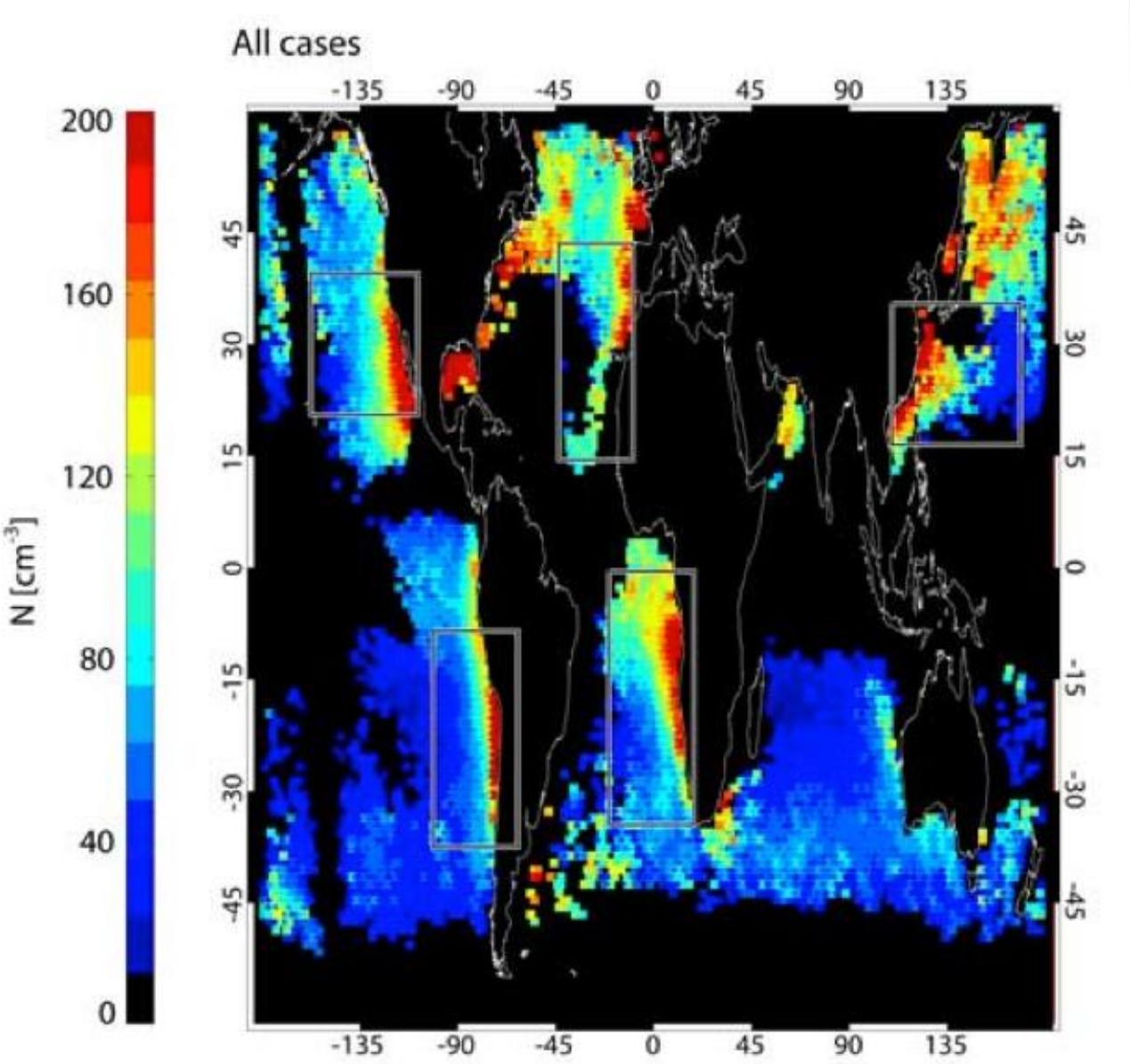
Very clean air, low aerosol concentration

High wind leads to high sea-salt concentration

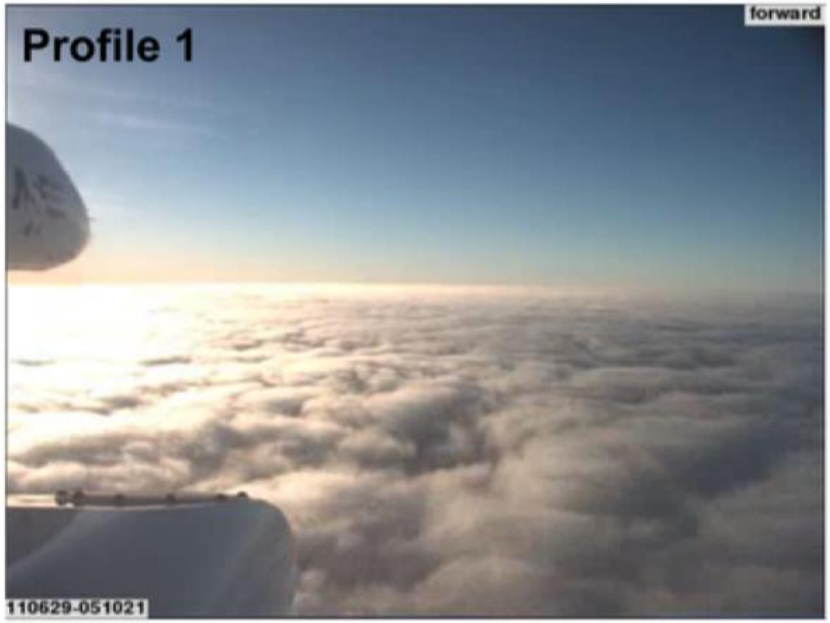
Few ice nuclei, only little mineral dust, some biogenic nuclei

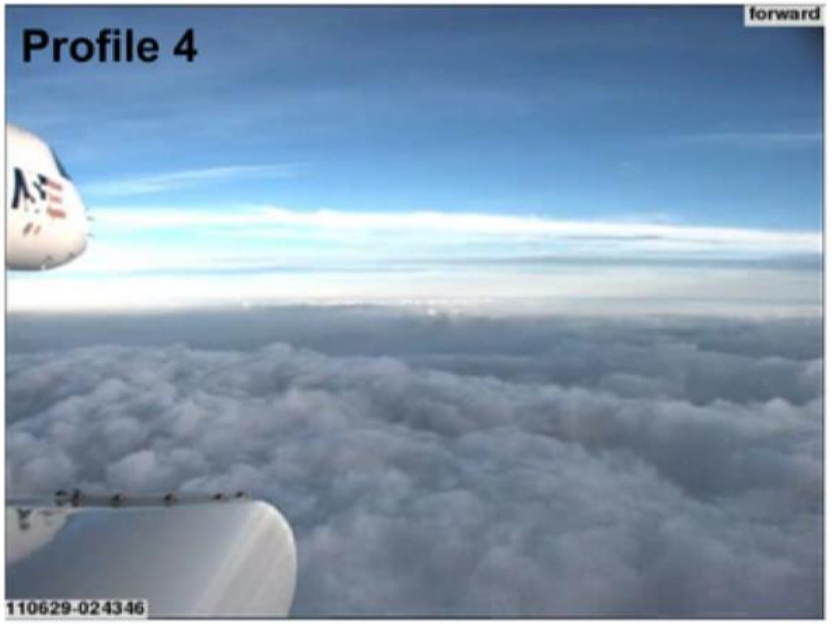
Can we get sufficient aerosol, thermodynamic, wind and cloud/precipitation to initialize and validate simple cloud models?

Can we get complete aerosol size distributions for near calm to 30 m/s?



Bennartz (2007)





Chubb et al (2015, in draft, do not quote)

Figure 3. Forward camera imagery of boundary layer cloud top conditions for the four profiles as labeled.

Chubb et al (2015, in draft, do not quote)

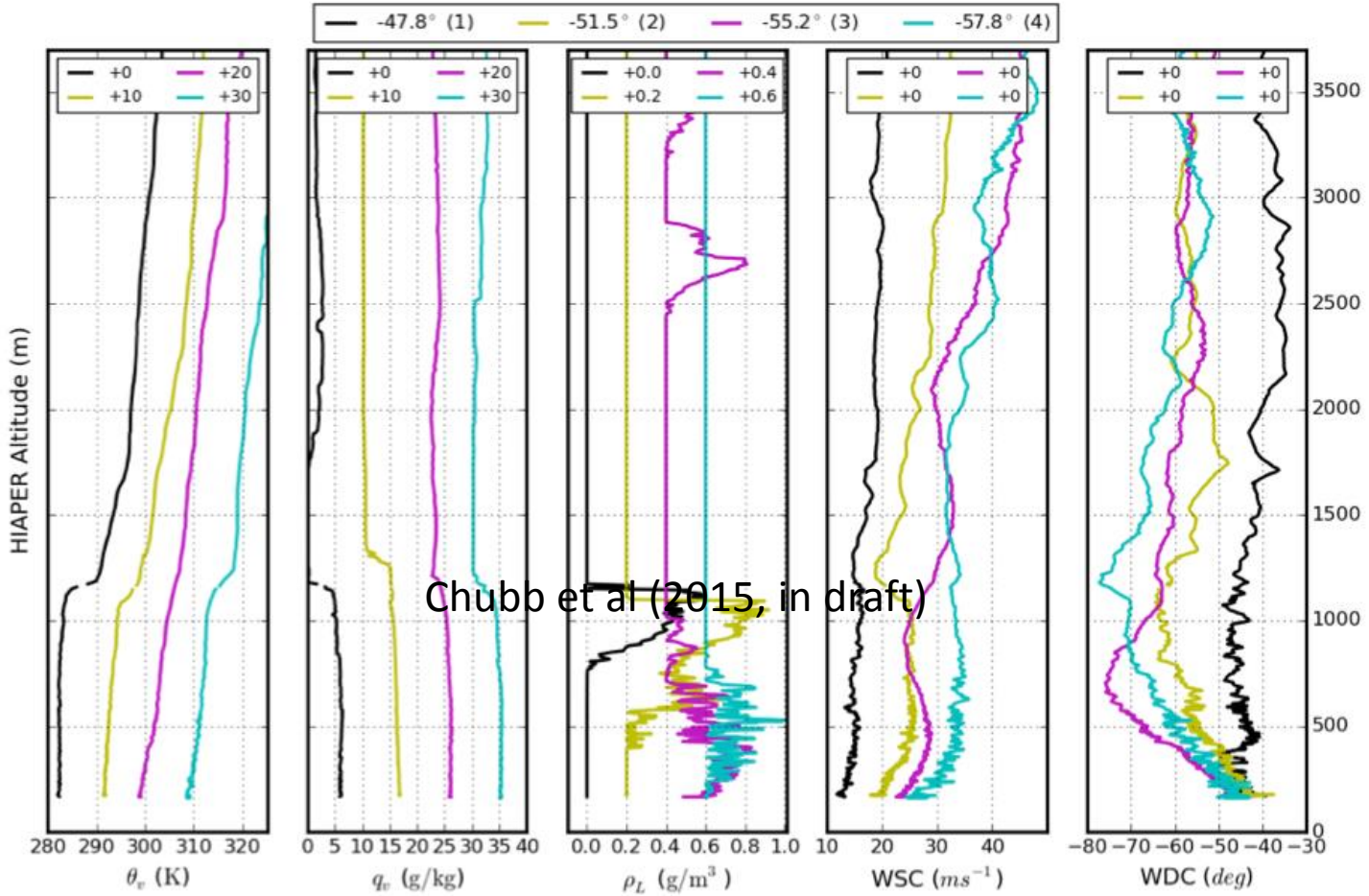


Figure 4. Profiles of thermodynamic variables within and above the boundary layer for RF06. From left: virtual potential temperature (θ_v); specific humidity (q_v); CDP liquid water content (ρ_L); wind speed (WSC); and wind direction (WDC). The colors indicate the profile number and location (see top panel). Note that for display purposes, the values for some profiles have been offset by the amount indicated in the legend in each panel.

Chubb et al (2015, in draft, do not quote)

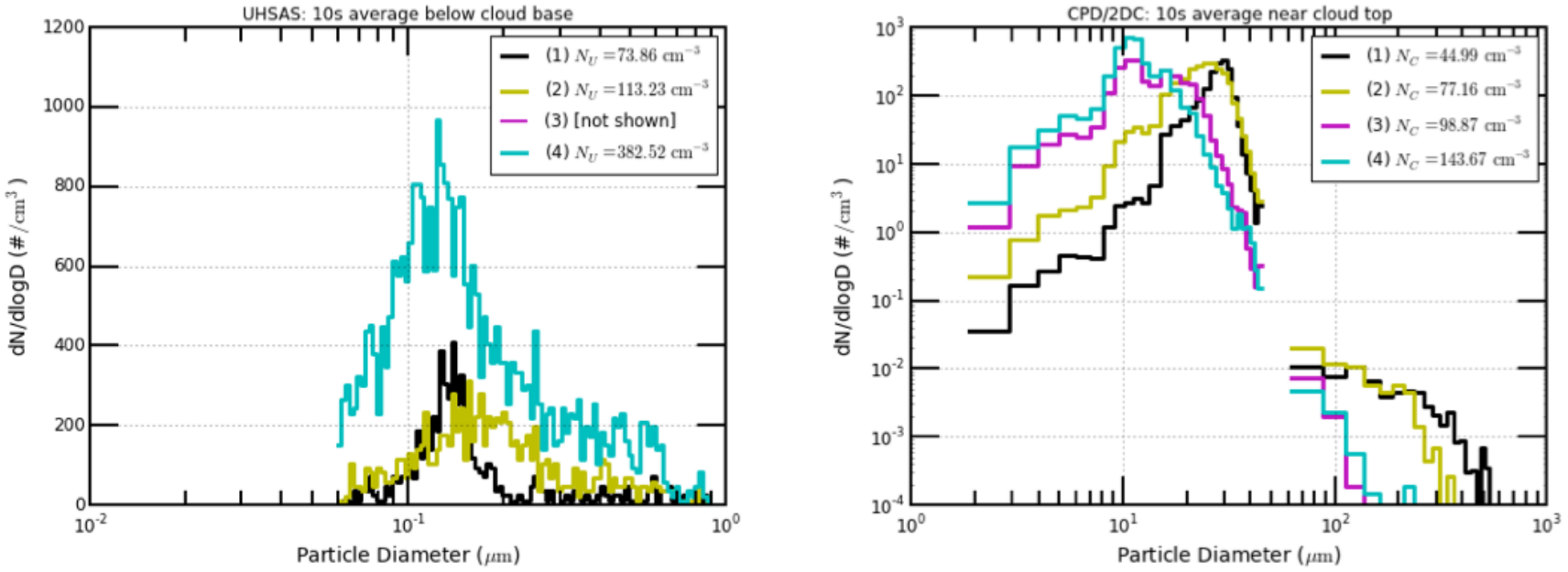


Figure 6. Left: Particle size distribution (10 second averages) for aerosol observed below cloud base by the UHSAS. Right: cloud droplets observed by the CDP at cloud top, and drizzle drops observed by the 2DC near cloud base (also 10 second averages; note logarithmic y-scale).